
Space Weather Technical Forecast

Issued on Thursday, 02 June 2022 at 13:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Active Electron Fluence. Slight chance of G1/Minor Storm intervals late day 4 (5th) from CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with a C1 flare observed from a prominence eruption on the east limb. There are four sunspot regions on the visible disc, with the most prominent AR3026 Dai/Beta in the northwest quadrant. AR3027 Dso/Beta in the southern central disc is also of interest due to its reverse polarity for a SC25 southern hemisphere spot. The other two regions are small unipolar spots. A potentially Earth-directed CME was observed from a filament eruption in the southwest disc at 02/0510UTC, although further analysis is required.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1 has gradually declined from near 500km/s to background levels of 350-400km/s. Density has been near to below average. The interplanetary magnetic field strength, Bt, has been weak, below 5nT, with the north-south component, Bz, varying weakly between -4 and +4nT, but predominately in the negative direction. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at background levels. The high energy electron flux (greater than 2 MeV) varied between Moderate and High levels, reaching 6870 pfu at 01/1510 UTC. Electron fluence has been above the Active threshold reaching 2.77e8 integrated pfu at 02/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Very Low, with a chance of further C-class flares and a slight chance of M-class flares, primarily from AR3026.

Solar Wind / Geomagnetic Activity: There is the slight chance of the weak Earth-directed CME from a filament eruption on the 1st arriving late on day 4 (5th June), although confidence is low. The CME on the 2nd has also been given a preliminary analysis, perhaps also giving a glancing impact late on the 5th, although further assessment is required. Otherwise, solar winds are expected to remain at background throughout the period. Geomagnetic activity is forecast to be mostly Quiet, but with a chance of rising to Active to G1 Minor Storm from any CME arrival on day 4 (5th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at background levels during this period. High energy electron flux (greater than 2MeV) is likely to continue at mainly High levels, with peak values only gradually easing later in the period, perhaps dropping out day 4 (5th) due to any CME arrival. Electron fluence levels are expected to be Active throughout (1e8 integrated pfu), but likely declining by the end of the period.

Figure 1 SDO aia 204 and SOHO C2 Showing filament eruption source and CME (to right)

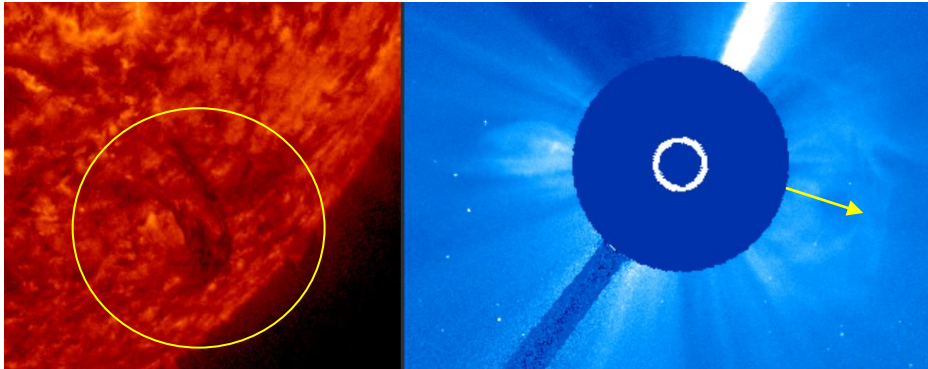
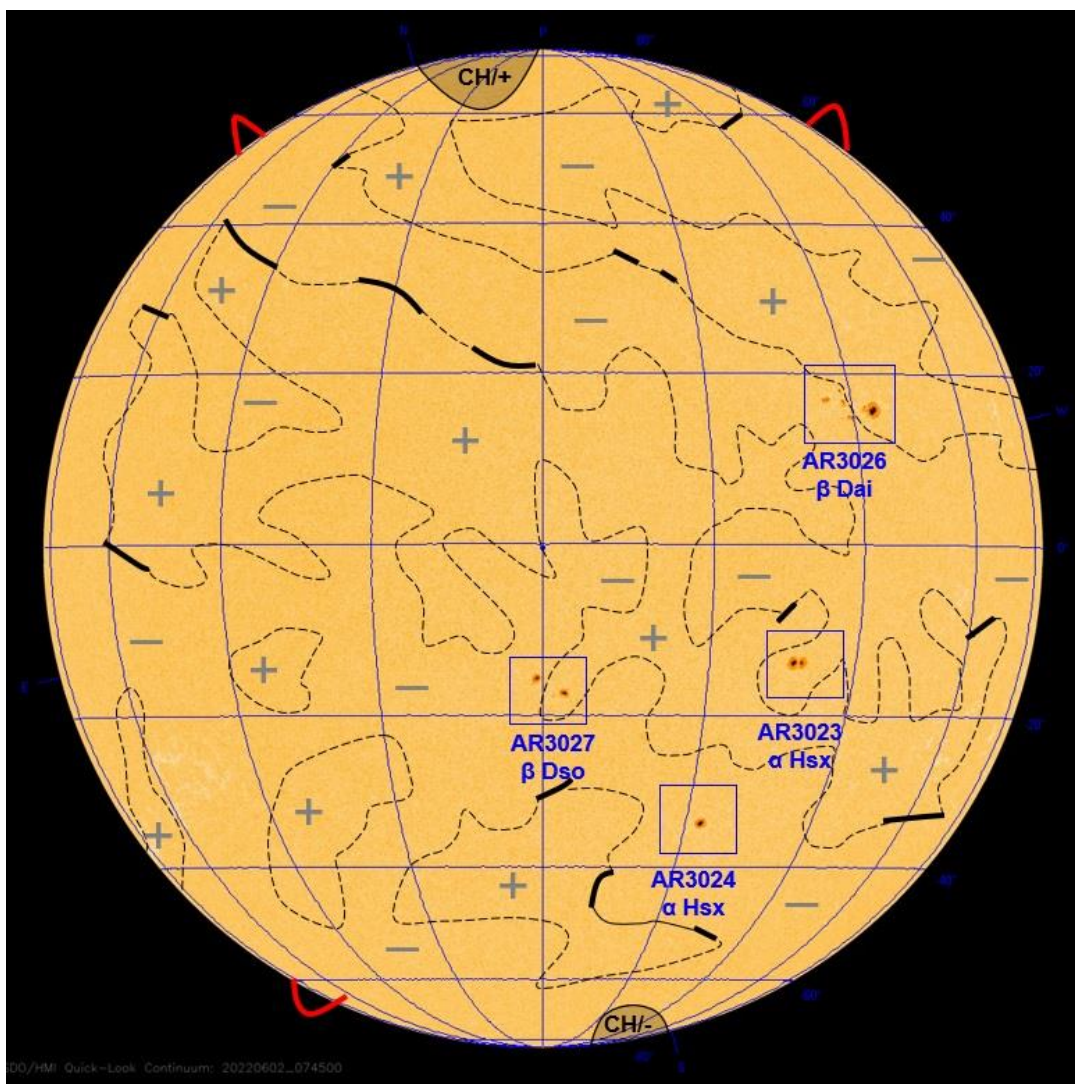


Figure 2. Solar Analysis Valid 02/0800 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A filament lift-off was observed from the centre disc around 01/0100 UTC, with an associated coronal dimming. A weak CME was produced and seen weakly in available coronagraph imagery. This has been assessed as a weak and slow CME, but gives a slight chance of a glancing blow late on day 4 (5th June), but with low confidence. A further CME since has been observed, leaving the southwest disc early on the 2nd. This has been assessed as also having the potential for a glancing blow, however we are awaiting further imagery and also the latest enlil run for a complete assessment of any likely arrival and strength of impact. These two CMEs may combine for an arrival on late on day 4 (5th).

Aside from the CMEs, background slow-winds are expected to persist through the period with no notable coronal hole fast wind enhancements expected.

Geomagnetic activity is forecast to be predominately Quiet throughout the period, but rising to Active with a chance of G1/Minor Storms from any CME arrival on day 4 (5th). If the filament eruption on the 2nd has a more Earth-directed component, there is the slight chance of G2 Moderate storms.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	1	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1300	Partial	Filament	10W 4N	252 km/s	05/1800 +/- 12 hours	Limited shock. Weak, and low confidence.
02/1400	Partial	Filament	47W 5S	465 km/s	Late 4/Day 5	Preliminary analysis – likely to change. Glancing impact

Figure 3: Enlil run without CME from the 2nd, with ensemble below.

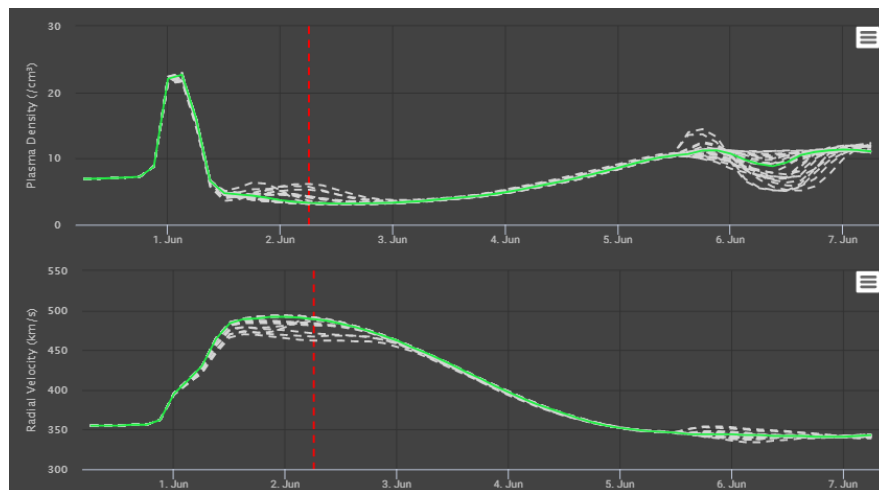
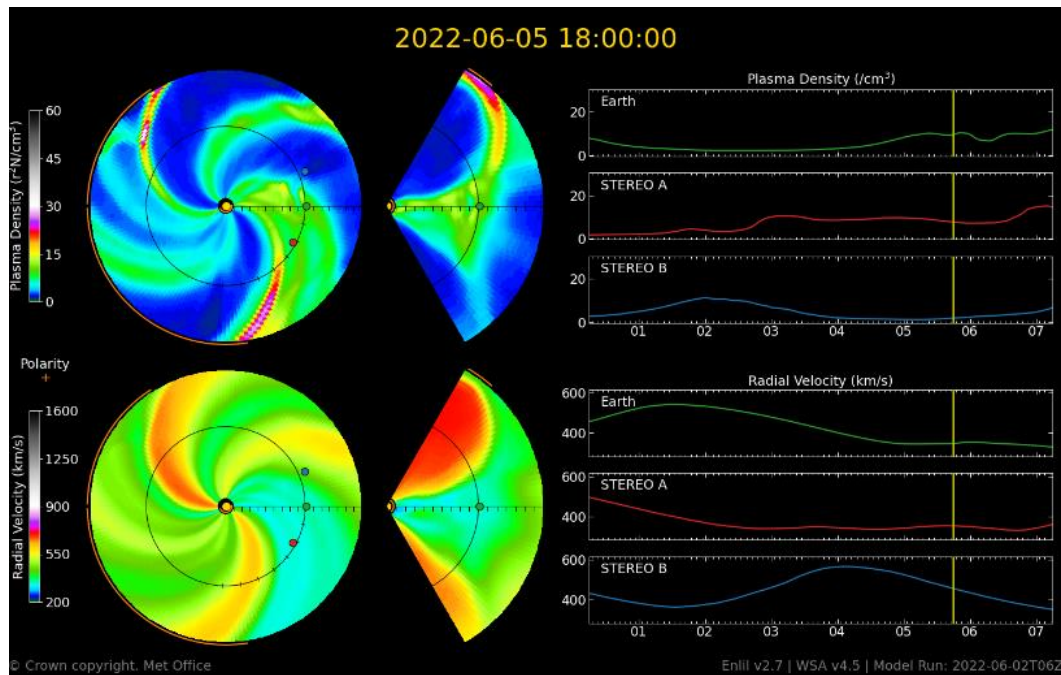
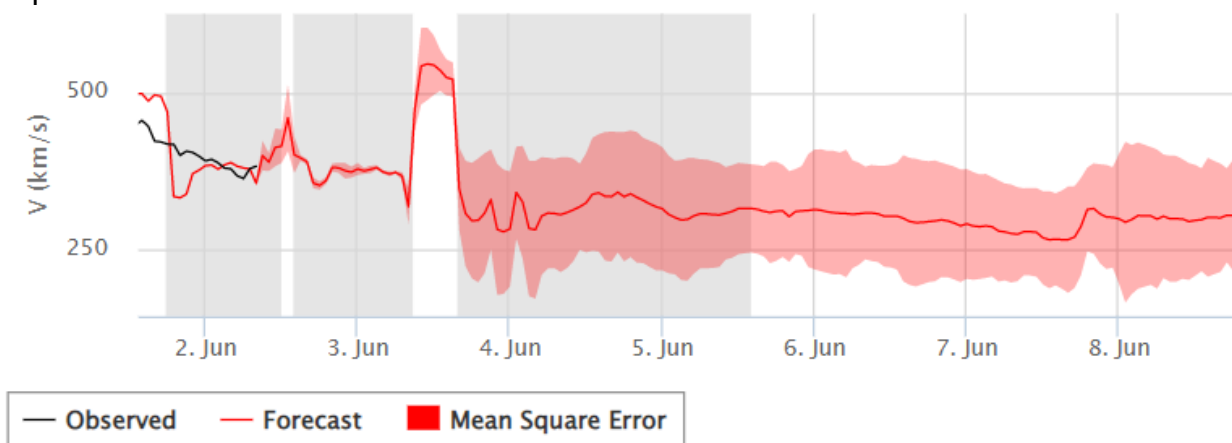


Figure 4: Solar wind persistence model. Shows the extended period of background winds expected.



Radio Blackouts - X-Ray Flares:

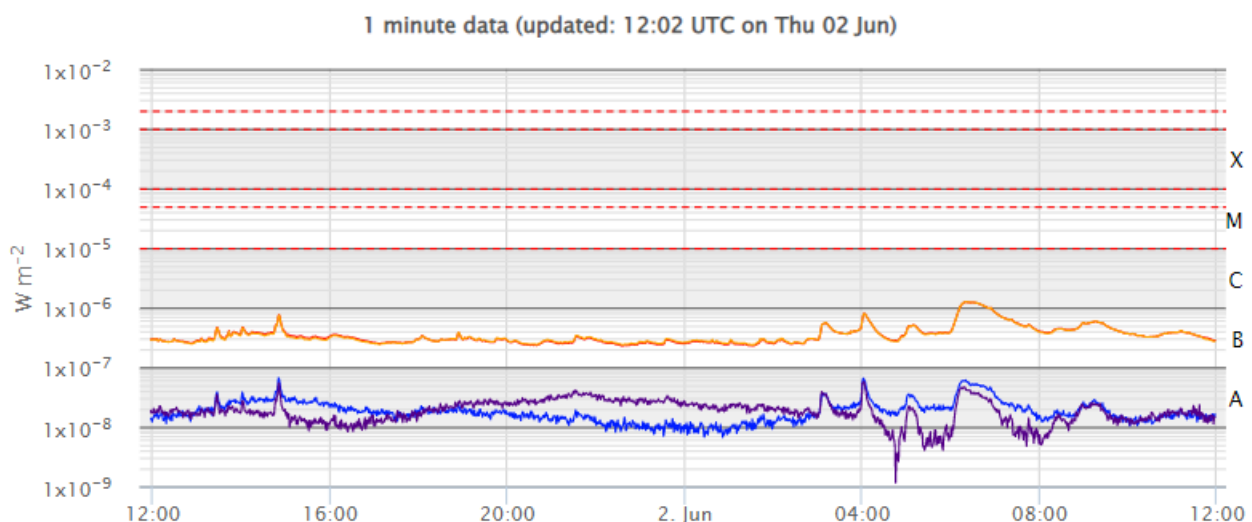
Solar activity is currently Low with one C1-flare occurring in the last 24 hours. Despite four regions on the Earth-facing disc, this flare occurred from a prominence eruption on the limb, although there is the potential for a sunspot region to be located at the source of the flare which may rotate onto the disc in the coming 24 hours.

The main region of interest on the Earth-facing disc is AR3026 Dai/Beta, however after growing during the 1st this has now stabilised into a relatively simple and small region. AR3027 Dso/Beta is another small region in the south disc, however of note due to its reverse polarity for a southern hemisphere spot according to Hale's Law. The other two sunspot groups are both small and simple unipolar regions.

Activity is expected to remain Low to Very Low with a chance of further C-flares, and with a slight chance of rising to Moderate due to isolated M-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 5: GOES 16/17 X-ray flux



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is expected to remain at this level, with the current region on the disc only having a small chance of notable flares.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	2	2	2	2
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 6: SDO Intensitygram and Magnetogram of AR3026 and AR3027. Reverse polarity of AR3027 can be seen, as these two regions are in different hemispheres, so should have opposite polarities.

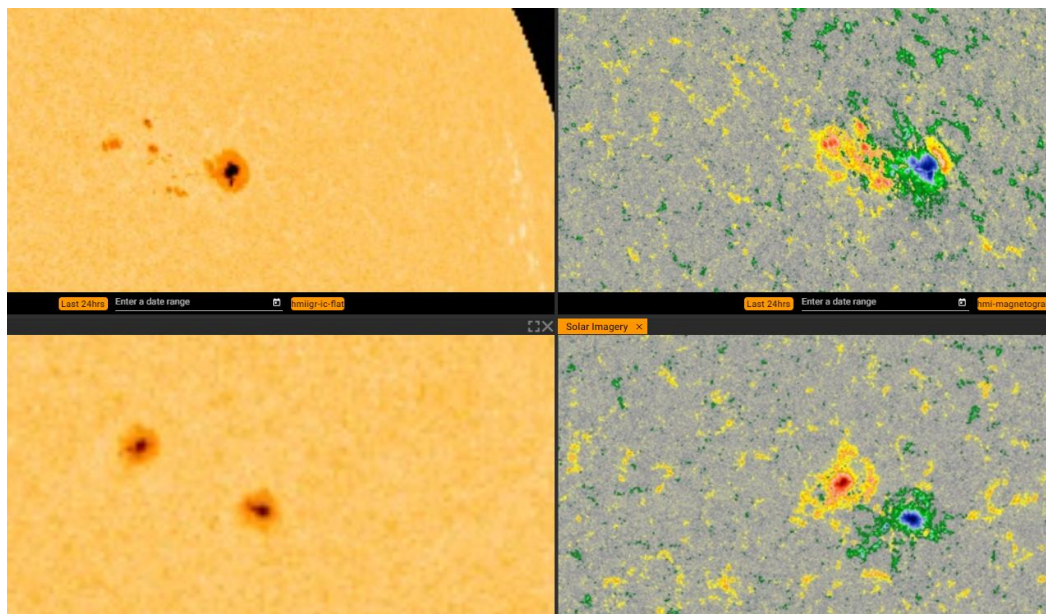
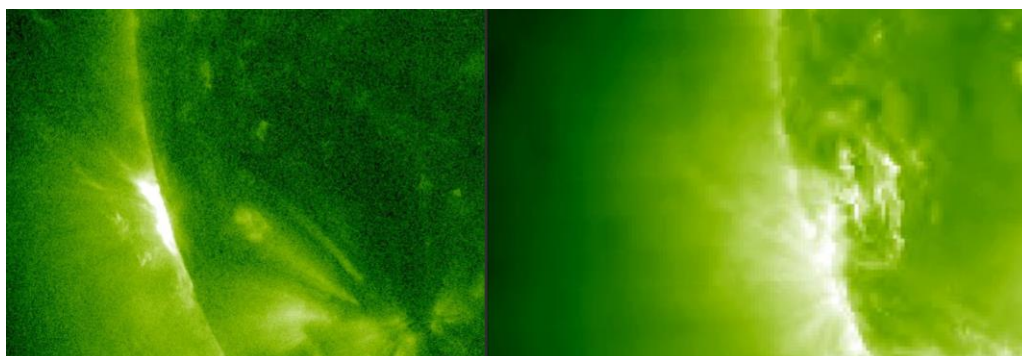


Figure 7: Prominence sourced C-flare (SDO aia-94 left, STEREO-A euvi right)



High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 has generally been at High (greater than 1000pfu) due to the recent fast wind enhancement. With no further notable disturbances forecast for the solar wind environment around Earth days 1-3 (2nd-4th), these mainly High levels are expected to persist, although peak values are likely to gradually decline. On day 4 (5th) the potential for CME arrival will bring the chance of flux levels dropping out.

The associated 24 hour electron fluence is currently Active (greater than $1\text{e}8$) and expected to persist at this level through the period, but with a slightly increasing chance of falling below by day 4 (4th). This is supported by REFM for the initial 24 hours, however beyond this REFM is likely reducing values too quickly.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	Yes	100	100	80	60
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 8: GOES-16 $>2\text{MeV}$ Electron Flux and associated Fluence with REFM

